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# LITTLE LAKE, GRANT COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
National Environmental Research Center
Minnesota Pollution Control Agency
Minnesota National Guard

July 1975

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PB 243 891

# U.S. ENVIRONMENTAL PROTECTION AGENCY
# NATIONAL EUTROPHICATION SURVEY

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
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REPORT

ON

# LITTLE LAKE

GRANT COUNTY

MINNESOTA

EPA REGION V

WORKING PAPER No. 120

WITH THE COOPERATION OF THE

MINNESOTA POLLUTION CONTROL AGENCY

AND THE

MINNESOTA NATIONAL GUARD

JULY, 1975

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# FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

## OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

## ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

## LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

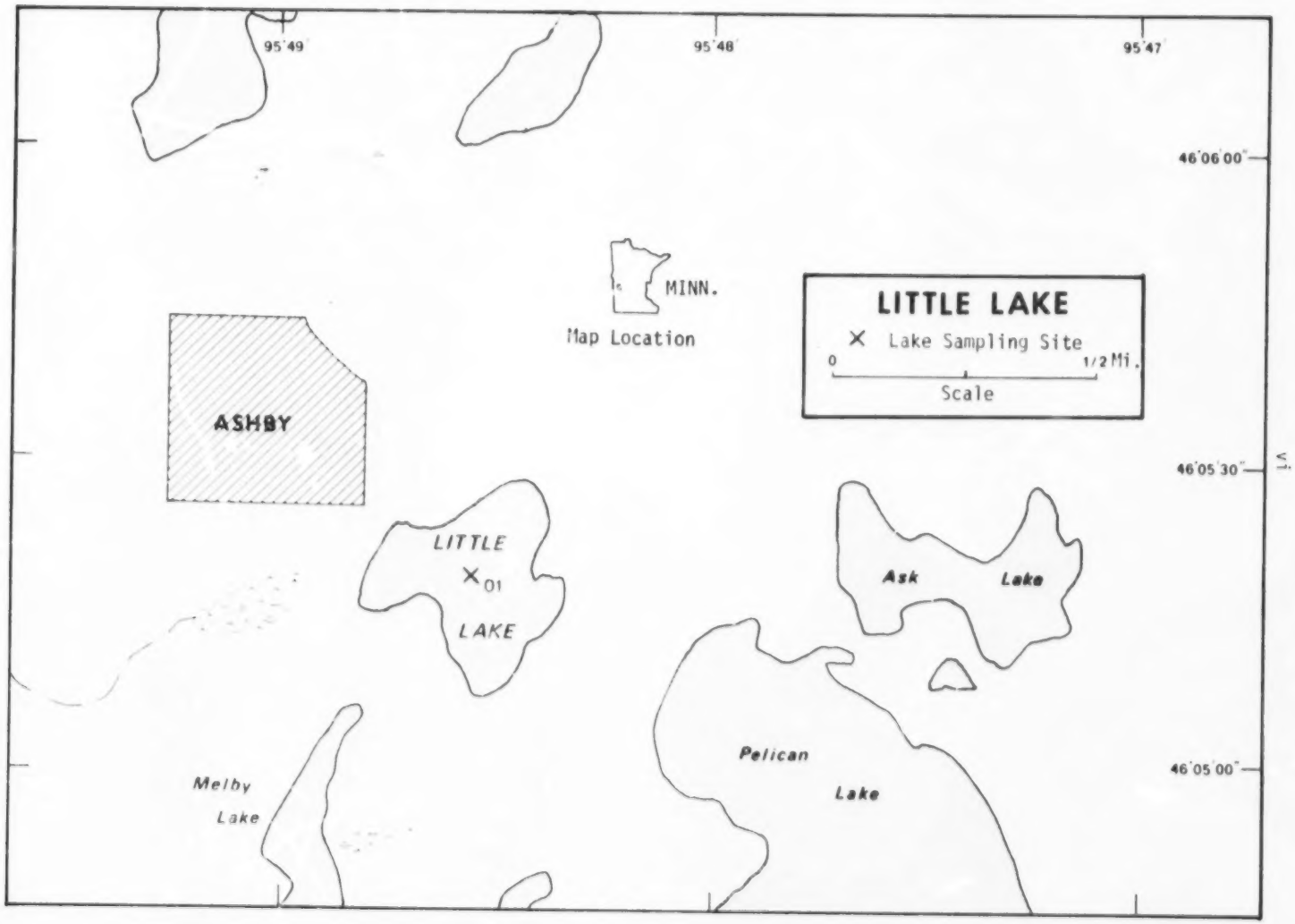
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

| LAKE NAME | COUNTY |
|---|---|
| Albert Lea | Freeborn |
| Andrusia | Beltrami |
| Badger | Polk |
| Bartlett | Koochiching |
| Bear | Freeborn |
| Bemidji | Beltrami |
| Big | Stearns |
| Big Stone | Big Stone, MN; Roberts, Grant, SD |
| Birch | Cass |
| Blackduck | Beltrami |
| Blackhoof | Crow Wing |
| Budd | Martin |
| Buffalo | Wright |
| Calhoun | Hennepin |
| Carlos | Douglas |
| Carrigan | Wright |
| Cass | Beltrami, Cass |
| Clearwater | Wright, Stearns |
| Cokato | Wright |
| Cranberry | Crow Wing |
| Darling | Douglas |
| Elbow | St. Louis |
| Embarass | St. Louis |
| Fall | Lake |
| Forest | Washington |
| Green | Kandiyohi |
| Gull | Cass |
| Heron | Jackson |
| Leech | Cass |
| Le Homme Dieu | Douglas |
| Lily | Blue Earth |
| Little | Grant |
| Lost | St. Louis |

| LAKE NAME | COUNTY |
|---|---|
| Madison | Blue Earth |
| Malmedal | Pope |
| Mashkenode | St. Louis |
| McQuade | St. Louis |
| Minnetonka | Hennepin |
| Minnewaska | Pope |
| Mud | Itasca |
| Nest | Kandiyohi |
| Pelican | St. Louis |
| Pepin | Goodhue, Wabasha, MN; Pierce, Pepin, WI |
| Rabbit | Crow Wing |
| Sakatah | Le Sueur |
| Shagawa | St. Louis |
| Silver | McLeod |
| Six Mile | St. Louis |
| Spring | Washington, Dakota |
| St. Croix | Washington, MN; St. Croix, Pierce, WI |
| St. Louis Bay | St. Louis, MN; Douglas, WI |
| Superior Bay | St. Louis, MN; Douglas, WI |
| Swan | Itasca |
| Trace | Todd |
| Trout | Itasca |
| Wagonga | Kandiyohi |
| Wallmark | Chisago |
| White Bear | Washington |
| Winona | Douglas |
| Wolf | Beltrami, Hubbard |
| Woodcock | Kandiyohi |
| Zumbro | Olmstead, Wabasha |


95°49'
95°48'
95°47'
46°06'00"
46°05'30"
46°05'00"
MINN.
Map Location
LITTLE LAKE
Lake Sampling Site
0
1/2 Mi.
Scale
ASHBY
LITTLE
01
LAKE
Ask
Lake
Pelican
Lake
Melby
Lake

LITTLE LAKE

STORET NO. 2748

## I. INTRODUCTION

Little Lake was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries were not sampled, and nutrient sources were not evaluated. Therefore, this report relates only to lake sampling data.

## II. CONCLUSIONS

### A. Trophic Condition:

Survey data show that Little Lake is hypereutrophic. Of the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, 58 had less and one the same mean total phosphorus, 56 had less mean dissolved phosphorus, and 27 had less mean inorganic nitrogen. Of the 80 Minnesota lakes sampled, 61 had less mean chlorophyll a, and 42 had greater mean Secchi disc transparency.

Survey limnologists noted that this shallow lake was heavily overgrown with rooted aquatic plants and observed algal blooms in progress in September and October, 1972.

### B. Rate-Limiting Nutrient:

The results of the algal assay show that Little Lake was nitrogen limited at the time the sample was taken (10/25/72). The lake data indicate nitrogen limitation at the other sampling times as well.

## III. LAKE CHARACTERISTICS

### A. Morphometry:

1. Surface area: 69 acres*.
2. Mean depth: unknown.
3. Maximum depth: >4 feet (based on Survey sampling).
4. Volume: unknown.

### B. Precipitation**:

1. Year of sampling: 22.9 inches.
2. Mean annual: 22.6 inches.

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* Anonymous, 1968.
** See Working Paper No. 1, "Survey Methods, 1972".

## IV. LAKE WATER QUALITY SUMMARY

Little Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one or more depths at a single station on the lake (see map, page vi). During each visit, a single depth-integrated (near bottom to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was collected for chlorophyll a analysis. During the last visit, a single five-gallon depth-integrated sample was taken for algal assays. The maximum depth sampled was 4 feet.

The results obtained are presented in full in Appendix A, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized in the following table. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix A.

A. Physical and chemical characteristics:

| | | FALL VALUES (10/25/72) | | |
|---|---|---|---|---|
| Parameter | Minimum | Mean | Median | Maximum |
| Temperature (Cent.) | 4.2 | (only one value) | | |
| Dissolved oxygen (mg/l) | 14.4 | (only one value) | | |
| Conductivity (μmhos) | 825 | 825 | 825 | 825 |
| pH (units) | 9.4 | 9.4 | 9.4 | 9.4 |
| Alkalinity (mg/l) | 190 | 195 | 195 | 200 |
| Total P (mg/l) | 1.480 | 1.480 | 1.480 | 1.480 |
| Dissolved P (mg/l) | 1.240 | 1.250 | 1.250 | 1.260 |
| $NO_2$ + $NO_3$ (mg/l) | 0.090 | 0.095 | 0.095 | 0.100 |
| Ammonia (mg/l) | 0.100 | 0.100 | 0.100 | 0.100 |
| | | ALL VALUES | | |
| Secchi disc (inches) | 16 | 42 | 30 | 80 |

B. Biological characteristics:

1. Phytoplankton -

| Sampling Date | Dominant Genera | Number per ml |
|---|---|---|
| 07/06/72 | 1. Merismopedia | 2,750 |
| | 2. Microcystis | 1,621 |
| | 3. Fragilaria | 796 |
| | 4. Flagellates | 449 |
| | 5. Chroococcus | 232 |
| | Other genera | 737 |
| | Total | 6,585 |
| 09/02/72 | 1. Dictyosphaerium | 9,474 |
| | 2. Merismopedia | 6,466 |
| | 3. Aphanocapsa | 4,436 |
| | 4. Microcystis | 3,083 |
| | 5. Flagellates | 2,632 |
| | Other genera | 5,864 |
| | Total | 31,955 |
| 10/25/72 | 1. Cyclotella | 10,152 |
| | 2. Flagellates | 6,364 |
| | 3. Microcystis | 4,242 |
| | 4. Fragilaria | 2,273 |
| | 5. Chroococcus | 1,970 |
| | Other genera | 6,060 |
| | Total | 31,061 |

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

| Sampling Date | Station Number | Chlorophyll a (µg/l) |
|---|---|---|
| 07/06/72 | 01 | 5.8 |
| 09/02/72 | 01 | 40.9 |
| 10/25/72 | 01 | 129.6 |

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

| Spike (mg/l) | Ortho P Conc. (mg/l) | Inorganic N Conc. (mg/l) | Maximum yield (mg/l-dry wt.) |
|---|---|---|---|
| Control | 1.050 | 0.183 | 15.8 |
| 0.005 P | 1.055 | 0.183 | 15.3 |
| 0.010 P | 1.060 | 0.183 | 14.8 |
| 0.020 P | 1.070 | 0.183 | 15.7 |
| 0.050 P | 1.100 | 0.183 | 15.0 |
| 0.050 P + 10.0 N | 1.100 | 10.183 | 108.4 |
| 10.0 N | 1.050 | 10.183 | 80.8 |

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Little Lake was high at the time the sample was collected (10/25/72). Also, the results show that the lake was nitrogen limited at that time. Algal growth was not stimulated beyond the control yield with orthophosphorus spikes. The addition of nitrogen alone caused a significant growth response in comparison to the control yield. However, the maximum yield was achieved with a combined spike of nitrogen and phosphorus.

The lake data indicate nitrogen limitation at the other sampling times as well; i.e., N/P ratios were 8/1 in June and less than 1/1 in September, and nitrogen limitation would be expected.

## V. LITERATURE REVIEWED

Anonymous, 1968. An inventory of Minnesota lakes. MN Dept. Cons., St. Paul.

## VI. APPENDIX

## APPENDIX A

## PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

274801
46 05 18.0 095 48 33.0
LITTLE LAKE
27 MINNESOTA

11FALES 2111202
3 0000 FEET DEPTH

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 00010 WATER TEMP CENT | 00300 DO MG/L | 00077 TRANSP SECCHI INCHES | 00094 CNDUCTVY FIELD MICROMHO | 00400 PH SU | 00410 T ALK CACO3 MG/L | 00630 NO2&NO3 N-TOTAL MG/L | 00610 NH3-N TOTAL MG/L | 00665 PHOS-TOT MG/L P | 00666 PHOS-DIS MG/L P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72/07/06 | 16 00 | 0000 | 20.5 | 9.4 | 40 | 325 | 9.00 | 198 | 0.060 | 0.040 | 0.020 | 0.012 |
| 72/09/02 | 14 45 | 0000 | | | 30 | 745 | 9.35 | 296 | 0.170 | 0.180 | 0.930 | 0.745 |
| | 14 45 | 0004 | 19.0 | 7.1 | | 790 | 9.30 | 292 | 0.120 | 0.130 | 0.910 | 0.765 |
| 72/10/25 | 15 20 | 0000 | | | 16 | 825 | 9.40 | 190 | 0.090 | 0.100 | 1.480 | 1.240 |
| | 15 20 | 0004 | 4.6 | 14.4 | | 825 | 9.40 | 200 | 0.100 | 0.100 | 1.480 | 1.260 |

9.

| DATE FROM TO | TIME OF DAY | DEPTH FEET | 32217 CHLRPHYL A UG/L |
|---|---|---|---|
| 72/07/06 | 16 00 | 0000 | 5.4J |
| 72/09/02 | 14 45 | 0000 | 40.4J |
| 72/10/25 | 15 20 | 0000 | 129.6J |

J VALUE KNOWN TO BE IN ERROR